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THE LAND OF YOUR POSSESSION[1]

By Dr. ISAIAH BOWMAN

DIRECTOR OF THE AMERICAN GEOGRAPHICAL SOCIETY OF NEW YORK; SINCE JULY 1 PRESIDENT OF THE JOHNS HOPKINS UNIVERSITY

WHEN we say that "man does not live by bread alone" we imply that bread comes first. Over the greater part of the earth and for at least three fourths of our two billion planetary population the will to eat is the primary urge of "eternally hungry man." "It was farming time, everybody talked about the land," was the way one old-timer summed up his motivations as one of the pioneers of the Middle West during the high tide of migration off the stony hillsides of New England to the flatter acres of the prairie plains. While the historical aspects of land use and land dependence tempt me to make excursions, I yield to the temptation at one point only. The title of my address is taken from Joshua, 1: 15, in recognition of the early land movements recorded in our common book of wisdom.

[1] Public lecture before the General Session of the American Association for the Advancement of Science, Minneapolis, Minn., June 26, 1935.

This antiquarian choice is supported by findings in Young's 1,000-page Analytical Concordance, which has about 1,600 citations on land (metaphorical and literal), while the two other main themes of the Bible, love and sin, come off with but 600 and 300 citations, respectively! The "pioneer fringe" was clearly recognized in that far day: "There remaineth yet very much land to be possessed." The migrants had an equally clear purpose: "That ye may live, go in and possess the land." In 1930 a wheat farmer of the High Plains of western Kansas, who had recently migrated from the eastern part of the state, answered my question of purpose as trenchantly as the record runs in Deuteronomy: "I came here, Mister, because I had to live." Cheap land, high-price wheat and the wet-period success of other High Plains farmers had drawn him forward to the degree that high taxes and high interest charges on the older farm had pushed him away.

That man now lives in a major zone of climatic risk, and it is the purpose of this address to look at his environment from the point of view of science.

The prairie and plains land that the American farmer for a century had gone into and possessed that he might live was "open to the plow," as it has been described, but much of it lacked other desirable qualities. Some of the deficiencies, such as timber in the treeless plains region, were first supplied by barge or rail from the nearest or the most profitable sources—notably, in time, the Great Lakes pine forests. The disadvantage of a thin farm crop in the drier western parts of the Great Plains was offset to some degree by large-scale farming machinery. The improved tin can made the cheap distribution of fruit possible and safe in places where fruit could not be grown profitably or at all. Tractor and header techniques helped lower the wheat farmer's production costs in some areas by vastly reducing man-power requirement. Good roads and motor transport in the past two decades have enabled him to push out farther and farther from the railways as the time and cost of haulage have been reduced. Land that changed use from stock to grain was bought at what seemed relatively low prices. The world market was still regarded as a reservoir of unlimited capacity. Extension of farm land was extension of our agricultural empire. Up to the time of the world war, as Dr. R. W. Murchie, of the University of Minnesota, points out,[2] the line of division had not become clear between the Neo-Malthusian philosophy according to which the world's population would presently require more food than the land could supply (with general birth control imminent) and the opposite philosophy, "imperialistic at heart," which "called for the speedy development and exploitation of the natural resources and the redistribution of population through migration." Migration was still encouraged in order that the frontier zone of agricultural land might be speedily occupied. "Canada throughout its history as a Dominion provided an excellent example of the effects of this policy" upon increasing national strength.

Almost with the speed and devastation of an epidemic there have overrun the world within the past decade new forces or old forces raised to new levels of power. The world wheat market became overshadowed by a menacing carry-over. In many sections the price of wheat fell below the cost of hauling it to market. Some communities in Saskatchewan, accustomed to the

[2] "Agricultural Progress on the Prairie Frontier," 1935, p. 1 (one of a series published by Macmillan of Toronto).

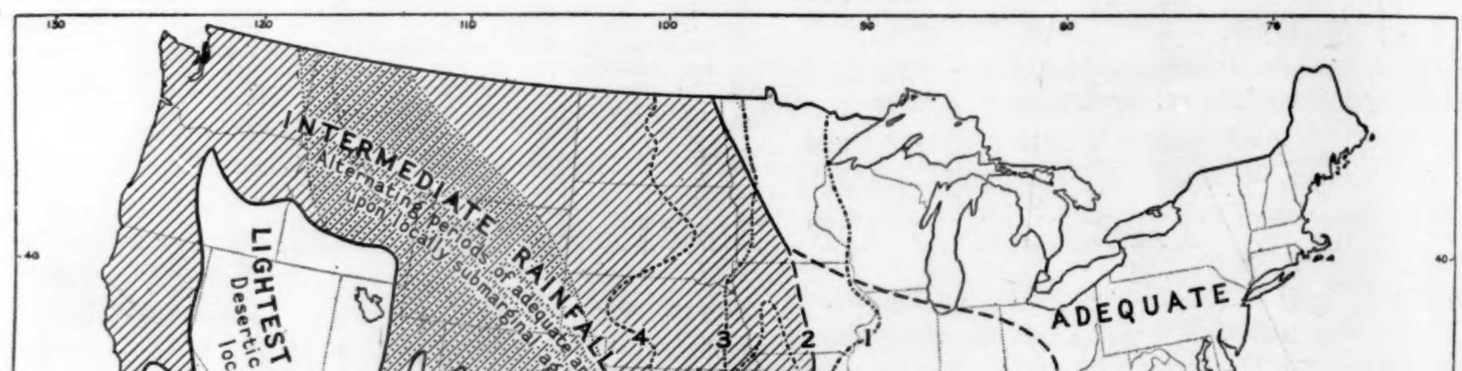

FIG. 1. Map of the United States illustrating the broad grouping of agricultural problems in three regions. In the easternmost region crops are in general dependable (see the local moderate exception marked by a broken line in the Middle West); in the central and northwestern region crops require specialized and extensive land engineering with limited irrigation; in the southwestern region water engineering is the basis of local agricultural development. Line 1 represents the eastern limit of "dry" years (see definition in descriptive caption of Fig. 2); line 2 represents the eastern margin of a western area of rainfall variability notably higher than that of the eastern part of the United States; line 3 divides the so-called humid East from the arid West on the basis of precipitation effectiveness; line 4 is the eastern border of territory having at least an occasional "desert" year.

power tractor, have gone back to draft horses for farm power. Many of the new settlers of the Peace River country of Alberta and British Columbia are starting at the horse-and-wagon stage, for pasture is cheaper than gasoline; and it has been rediscovered that time has less value than capital invested in costly and dispensable machines that are idle most of the year.

Our own wheat belt has experienced a revolution. The accompanying "risk maps" show some of the physical handicaps of the region. In many sections a farm can now be bought for less than the price of the buildings—the land is thrown in as a mere *situs*. Wheat production on the High Plains, and adjacent areas to the east and north, has been in a state of unstable equilibrium for some time, owing, among other things, to the 90-day work periods of the one-crop wheat lands of the region brought into cultivation largely since 1915. When the drop in the market price of grain was followed by the severest drought of our pride in the use of reason in other arcs of human experience. It is said that Kansas is the only state in the Union that contains more trees now than it did before it was settled. But even here man's benevolence and wisdom are limited to the eastern two thirds of the state. In the western third, right in *the area of greatest climatic and agricultural risk,* the protective sod has been ripped off and the soil pulverized by the repeated cultivation essential to dry-farming, with the result that whole fields have taken flight. In some places the ground has been literally blown off down to the plow sole.

We habitually hope for the better with respect to those destructive forces that we have long attributed to Providence. Perhaps this year the drought will end. But even if that desirable change is realized, the bad effects will last for some time; and hope plays but little part in bringing back a state of balance that man right now continues to disturb with criminal thoughtlessness. Hope will not bring the sod cover back.

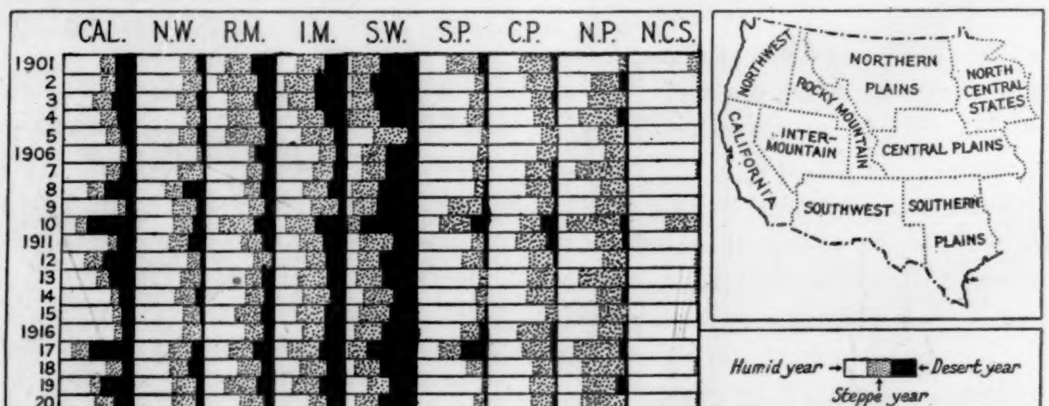

FIG. 2. Diagram, after Russell, showing the prevalence of desert, steppe and humid years in the western United States in the period 1901–1920. The classification is based on the records of 569 stations and the limiting values are defined thus: "at the mean annual temperature of 55° F. places receiving between 9.5 and 14.0 inches are classed as Steppe . . . those receiving less than 9.5 inches as Desert. . . . At 70° F., Desert areas may receive as much as 13 inches of precipitation." (R. J. Russell: Climates of California, *Univ. of California Publs. in Geogr.*, Vol. 2, No. 4, 1926, p. 76.)

record, and wide-spread wind erosion followed the drought, the economic distress characteristic of the 80's and 90's was intensified, and the general problems of land use and the ultimate economic fate of the people in the area were laid on the lap of the Federal Government.

Now the will of man is once more recognized as a part of nature. The environment of the drier parts of the Great Plains has suddenly had injected into it a new psychological element. For the drought and the dust storms are in part what we think they are. They are not merely malign nature. While in simple teleological phrase it may be said that God made the drought for ends of his own, it was man who raised the dust because he did not have the proper ends in view. We have long recognized our extraordinarily illogical contrarieties in some respects, in contrast to

After the fields have had their top-soil blown off, we enter a long period of both waiting and experimentation to see if the grass will grow again or if a wetter period in the future may not be required to restore the cover, with some areas eroding meanwhile to a still more extreme stage of destruction. Some of the effects of plowing and wind-stripping will be projected into the future, we can be sure. In our troubled times we can see the wisdom of a Bacon, who wrote of "Seditions and Troubles" that one of the first remedies was "the improvement and husbanding of the soil."

In any event, and whatever the balance between hope on the one hand and soil and weather possibilities on the other, we ask, wisely, I think, what kind of people and what kind of society will the high-risk areas of the western Great Plains support? Do we want that kind? Our people are our greatest resource.

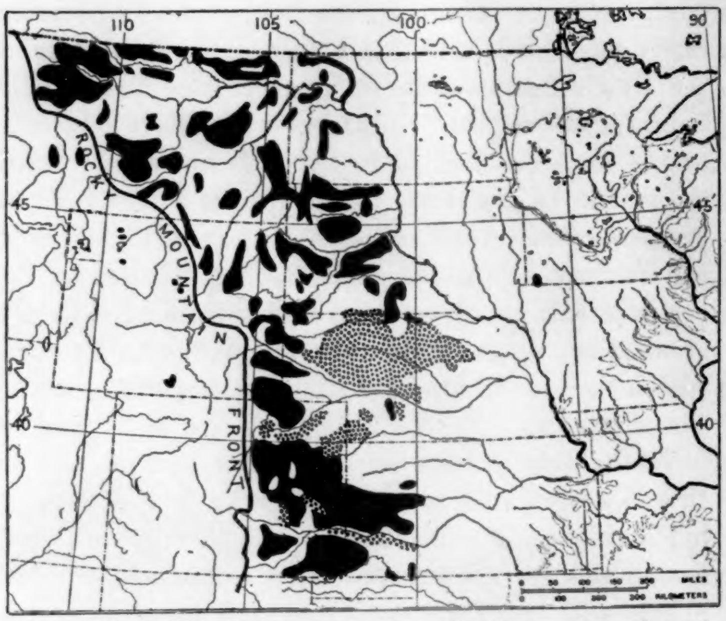

FIG. 3. Solid black represents principal areas of agricultural risk in the Central and Northern Great Plains (see text); stippling represents "sand-hills." From land-classification maps of the United States Geological Survey.

"Tell me what society you want," says Zimmerman, "and I will tell you what your resources are." We are dealing with a social, that is, a cultural complex as well as with a complex of natural conditions and forces. Walter, of the Meteorological Service of British East Africa, wrote in a paper read before the Kenya Society for the Study of Race Improvement: "I desire to call particular attention to a point which is often missed by research workers when the human element is in question. Do not let us generalize! A climate suitable for one type [of settler] may be very unsuitable for another. . . ." Once nature seemed capricious, but the deeper we study her the better able we find ourselves to master or deflect or avoid some of her forces. It is man himself who now also needs understanding and control by reason. If nature were as capricious as man we might well give up. If we invoke the aid of science, what relation have its rationalities, points of view and results (including perhaps its forecasts) to the problem of land use in the marginal areas of the Great Plains?

First, neither a scientist nor a government official can handle the problems of the drought on a hunch. We can never solve "the problems of the drought" by stopping the drought. We can only provide to some degree against its effects; and if we were forewarned against its coming the degree of provision against its effects could be greatly increased. Likewise, we can never solve the problems of soil erosion by stopping erosion. We can only reduce the rate of erosion. The effects of drought and soil erosion will outlast all the regulatory schemes of to-day. Amazement at the dust storms should not lead to the neglect of long-range studies. A strong force of experts should be working on the mass of climatological data on the Great Plains accumulated during the past 50 years by the Weather Bureau. If this were done the result would certainly be more valuable over a ten-year period than all the gold produced in the Klondike. Would that a 1935 rush toward this mountain of information followed the Minneapolis meeting of the association! It is such a rush that ought logically to be joined with the rush to plant trees. For the immediate problem of the semiarid western part of the Great Plains is not only where to plant more trees and shrubs, waiting 20 to 30 years for results, but also and more urgently to work out a land-use plan for the grasslands of the vast region west of the proposed shelter belt and to start operating the plan now. The climatic map shows us how vast is this marginal area. Without shelter-belt possibilities, it is in dire need of having its climatological risk defined and its people redistributed accordingly. The relief now provided to three fourths of the population over huge areas has transferred the problem of land use from the local or county agencies to the state and possibly the federal agencies. If re-

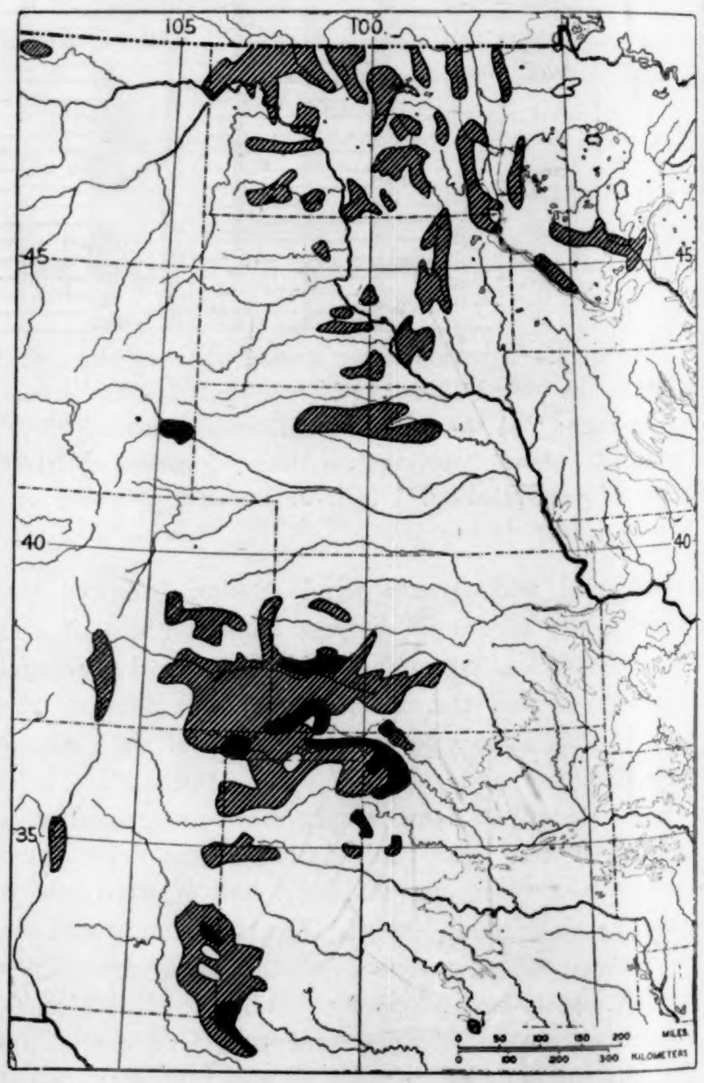

FIG. 4. Areas of most intense recent wind erosion are shown in solid black; less intensely wind-eroded areas are shown by diagonal ruling. From the Soil Conservation Service.

lief is a permanent feature of land use in areas of maximum risk, it is logical that the sources of relief shall have a right to inquire whether the risk shall be allowed to continue.

There has become available during the past few years a set of land-classification maps published by the Conservation Branch of the U. S. Geological Survey. From them I have had traced off two land classes, the so-called "farming-grazing land" and the "grazing-forage" land. The one has "crop failure in dry years," and the other "crop failures except in good years." This may look like a distinction without a difference; but this need not trouble us, for on the map the two types are lumped together. Outside these two areas the land is either so well favored as to involve the farmer in little risk or so ill favored as to exclude farming. In the two types where risk is greatest lies the land on which in favorable years farmers are most strongly tempted to grow wheat. There the wheat farmer literally gambles on the rain. The two types represent areas of maximum risk not because they are occasionally very dry but because they are occasionally so favorably wet as to cause agricultural overextension. To these difficulties has recently been added wide-spread and unexpectedly severe wind erosion. While the farmer is waiting for a return of moister years, the wind carries his farm aloft. The problem of the farmer turns on the question, How far can he go in reaping the bounty of the land in wet years and yet survive the penalties of inevitable drought? The problem of the government is to determine whether a man shall be allowed to grow grain in places where he *can* do so and *ought* not to. Here is a border of settlement of shifting fortunes as distinctive in type as the corn-belt type or the cotton-belt type.[3]

In organizing fundamental climatological research as a basis for expressing degrees of risk in the agricultural gambling belt, we do well to realize that what is caught by the rain gauge is only a statistical expression. "General distribution" maps do not amount to much. We need to know details, subregion by subregion. Generalization is one of the great and useful processes of science, but it has its severe limitations. In habitational studies of the semiarid region we have to know the small but critical regional differences in rainfall habit. The larger the number of rainfall stations we install the more irregular the pattern of isohyetal lines always becomes. Plottings of rainfall probability on the basis of too widely scattered stations suffer accordingly. It is as if one made a topographic map of Montana on the basis of elevations obtained by sounding lines let down from a few balloons equipped with barographs. It is not only the "*land* of your possession" that we want to know about but also the sky over it, the rain that falls upon it, the paths of the storms, the amount and incidence of winter snow, the depth to and the degree of permanence of the ground water, and the degree of reasonableness or lack of response to reason of man settled upon the land. When I asked my guide in Peru how often it rained on the arid coastal hills north of Mollendo, he answered, "Segun el temporal y la Providencia" (according to the weather and to Providence). How far has science really given us a better answer?

First, may I refer to the widely heralded shelterbelt. The map shows its position as originally published in an article in the *New York Times*[4] by the chief forester, F. A. Silcox, and its now revised and more easterly position as published in SCIENCE by Dr. Raphael Zon.[5] The operations of tree planting in this zone will be limited by a number of factors, of which rainfall is one. Graphically to represent the facts on which the general location of the belt is based, critical

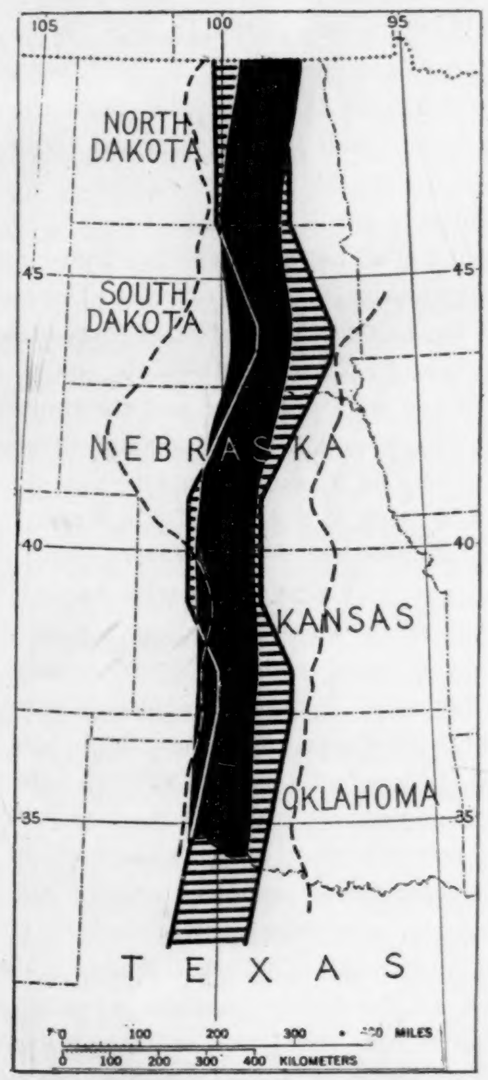

FIG. 5. The solid black indicates the shelterbelt as first located by Silcox, the ruled area represents the location of the belt as modified by Zon. The adjacent lines represent rainfall limits which are described in the accompanying text.

[3] Isaiah Bowman, *Geogr. Rev.*, 21: 22–55, 1931.

[4] *New York Times*, July 29, 1934.

[5] R. Zon, SCIENCE, April 26, 1935, pp. 392–93.

climatic limits are shown on either side. On the left is a broken line west of which more than half of the years (in the period 1910 to 1933) were semiarid and we may therefore conclude that in general trees will not grow on the uplands west of that line unless they are irrigated like a crop. To the right of the shelterbelt is a broken line east of which the rainfall is sufficient to permit trees without special drought-resisting qualities to grow. Between these two outer lines is a broad belt within which drought-resistant species *may* grow and in which all suitable species will do better if planted in the most favorable sites. Obviously, these sites require a study not only of rainfall and snowfall but of the water-holding capacity of the soil, the depth to adequate moisture zones, prevalence and duration of hot winds, slope exposure, and the like, as well as the degree of success of tree-planting experiments of the past under closely observed and well-analyzed conditions. Tree-plantings toward the eastern margin of the shelterbelt are more likely to succeed (if favorable sites are selected), and those near its western margin are more likely to fail. Some experimental plantings in the best sites near the western margin and even well beyond it show, however, that local success is possible on that margin.

The rainfall records on which the location of the western margin of the shelterbelt is based have been insufficiently analyzed. Zon refers to the close coincidence of the belt to the 15-inch average rainfall line on the north and a 22-inch line on the south. But the incidence of semiarid years for half the time raises the question as to how the wet years and dry years are grouped, subregion by subregion, and how such groupings affect the risk to the life of plantings. Five dry years in succession are a far different thing from five dry years in regular alternation with five wet years.

There are many ways of stating the rainfall of a region, and detailed research upon variabilities of amount, intensity, frequency, growing season water requirements by stages, insolation, slope, and the like, is required if the *effectiveness* of rainfall is to be ascertained. A generalized rainfall map tells very little about the rainfall effectiveness at any given locality. The native vegetation supplies one of the readiest guides to water effectiveness in specific environments because it is the result of interaction over a long period of time of all the factors in their varying combinations. The natural vegetation is thus an approximate indication of agricultural productivity. A noteworthy example is the line of division between the tall-grass and short-grass formations separating "the highly productive farm lands of the prairie from the less productive ranch lands of the plains. . . ."[6]

According to Zon, more than half of the shelterbelt, or 57 per cent., lends itself to tree plantings; about 39 per cent. is difficult to plant; and about 4 per cent. may be planted to forest in solid blocks, "but each planting must be adapted to the soil conditions of every farm and oriented to the damaging winds prevailing in each locality," following narrow ravines in the "breaks," as the eroded scarps are called, as windbreaks around farmsteads and schools or in narrow strips around fields. The effect, one concludes, will be as severely local as the plantings. One may be permitted to doubt that the proposed plantings will provide the part of the semiarid region where operations are contemplated with "the amenities of a higher cultural life."[7]

During the past two years the Science Advisory Board has advocated a deeper climatological study of the Great Plains as part of a land-use program in order to determine with greater assurance where economic effort of a given type should be concentrated. Climatological studies are basic to soil and water conservation measures. Through the interest of Dr. Bennett and Dr. Lowdermilk, the Soil Erosion Service (now the Soil Conservation Service) has authorized such a study. On the physical side there is no dividing line between soil-erosion problems and the remaining problems of land and water use. It is necessary to know not merely the existing degree of soil erosion but also the erosion potential before we can make sure of that "continuing wise use" which Theodore Roosevelt set up as the main general objective of conservation. Soil is an energy source that is not renewable at all in some places from which it is lost and is renewable in other places only at an uneconomic cost. Even when the loss of the surface soil is not imminent, its rate of depletion is a subject of concern if this is greater than the replacement rate. Its waste is deplorable from any standpoint: the future degrees of national self-containment and of dependence upon foreign sources of supplies of vegetable origin are unknown, and we are therefore unable to say what the future pressure may be upon our agricultural land apart from any natural increase of population. We shall always need all our best land. Some of our most devastating erosion has been on our best land.

Population can not be moved about at will, even if plenty of good land is available outside badly eroded areas. The accustomed cultivation technique is a limiting condition. Accustomed neighbors are a desideratum. Yet poverty deepens if farmers are left upon the eroded areas. The human erosion is as important as the soil erosion which it follows. "I dig my well, I plow my field," runs a Chinese poem, "what care I who rules the land if I am left in peace?" But this may be the peace of extinction of whole communities unless those who rule the land choose to care.

[6] H. L. Shantz, *Annals*, Association of American Geographers, 13: 100, 1923.

[7] *Ibid.*, p. 394.

It is not merely more or less annual rainfall that is the basis of subdivision according to "continuing wise use" of the semiarid region of the Great Plains. There are different kinds of rainfall. To determine the amount that falls in the crop-growing season is not enough. The several parts of the growing season differ markedly in the degree of response of crops to rain. In any given year the greater part of the growing-season rainfall may occur in the wrong month for good crop effect. The rise and fall of the groundwater follows only approximately the increase and decrease of rainfall; and the soil moisture (available) changes are but little better fitted to the rainfall variations. It is vital to *interpret* rainfall *in detail* in terms of plant physiology and crop potential under a wide variety of conditions. We want to know what a rain, any rain, is worth to a crop, whether of grass or grain, and what are the indices of worth. One such index is the determination of what became of the rain received up to a given date. Again, the temperatures of the growing season may be so high that the otherwise beneficial effects of a given rainfall may be almost wholly lost. Rapid transpiration in the Great Plains in part offsets the higher summer rainfall. The afternoon windiness is higher than that of any other part of the country.

In the northern Great Plains, snowfall may play an important part in determining the amount of available soil moisture, and systematic snow surveys are still a novelty and in the promotional stage. The average annual snowfall of the Dakotas is 30 inches and the duration of snow-cover is 120 days; for western Oklahoma the figures are 10 inches and 20 days; in southwestern Texas, the average snowfall is but 1 inch. The average annual number of days of snow-covered ground ranges from 120 in the extreme north to about 10 in central Oklahoma.[8]

Climate, from the standpoint of a growing plant, means a number of conditions *in relationship*. That is why plant experimentation should go hand-in-hand with intensified climatological studies. Only as they are coordinately analyzed shall we be able to define regions of unlike land use, scientifically reduce the area of risk, and improve methods of use, section by section, throughout the semiarid West.

Pasture management is no less important than cropland management. One of the fundamentals of a study of land use and soil erosion (including wind erosion) in the drier Great Plains is to know more about the phenology of the region—the times of flowering and seeding (not the growing season) of range grasses. One day we shall have an analytical grass map of the range lands, according to maximum use in different types of rainfall years. We shall then sample plots of different range regions (as we now measure the trees of sample plots in the forest) and work out our range practices accordingly. When such a master grass map is produced we shall know where we can best stimulate the growth of grass, both indigenous and introduced varieties. Overgrazing on grassland is as bad as over-pulverization on fallowed fields and fields devoted to row crops. Grass, on the average, is 65 times as effective with respect to water conservation and causes 5 times as much rainfall to sink into the ground, under comparative conditions, as clean-tilled crops.[9]

Whatever we learn about land we have more to learn about the adaptation of shifts of population to our scientific findings. Writing of South Africa, Du Toit[10] quotes a line on the "ever-changing present," cautions against too-ready acceptance of constant appeals for new irrigation enterprises in view of "new and unforeseen developments . . . both here and abroad" that have altered the basis of many of the irrigation settlements, and deplores lack of study of "precise use" and the influence of politics. Are we leveling off living standards by ransoms levied on the better areas by government edict or do we recognize that the diversities of the physical environment may inevitably call for somewhat similar diversities in economic status?

The distinction between scientific agencies and planning agencies in land-use studies can not be too strongly emphasized. Our scientific agencies of the government are fact-finding agencies, and their research is directed mainly toward the better determination and improved statement of *facts*. In the early years of the century policy-making got mixed up with fact-gathering and possibly with no detriment to the use of forests and minerals. But a government ought not to allow policy-making to lower the standards of its scientific services. It is on the basis of facts that policies should be determined. To make the "facts" fit the current policies is detrimental alike to policy and to science. A politician is most dangerous when, as medicine man, he juggles facts. The citizen may want to have things "put plain," but the solutions of some problems are hard and complex, inasmuch as they deal with not yet fully ascertained or analyzed facts, intricately related forces, current views and mutually unrelated tendencies. Not all distributional facts can be readily understood by "a glance at the map."

Speaking in this place, where one almost overlooks the drought-stricken areas of the past few years, may I refer to studies[11] carried out since 1930 on the mar-

[8] J. B. Kincer, *Annals*, Association of American Geographers, 13: 73, 1923.

[9] H. H. Bennett, SCIENCE, 81: 326, April 5, 1935.

[10] Alex. Du Toit, *South African Journal of Science*, 31: 1–24, ref. on p. 5. 1934.

[11] Carried out under the auspices of the American Geo-

ginal lands and settlements of selected parts of the West and based on climatic records, tree rings and the history of lake fluctuations in the Great Basin region and on field notes made in 1930 and 1932 in the territory extending from the Texas Panhandle to the Canadian border. The questions one naturally asks in viewing the region are: (1) How long will the drought last? (2) Was the West ever as dry as it is now and will equally severe drought conditions return soon? (3) Is there a general tendency toward a permanently drier climate? (4) Has our Western land been permanently disabled, and what measures can be taken to offset the bad effects of drought?

How long will the drought last? There is no known way of predicting the end of a drought. There is no "apparent conformity to any law of succession" (Kincer) in rainfall variations. The change from a wet period to a dry period is comparatively uniform, but the time intervals between successive maxima are decidedly irregular. Regular cyclic changes in rainfall have not been identified in the records; there are only pseudocyclic appearances. Climatic changes appear to be inevitable and to be as yet unpredictably irregular, whatever their cause. The power of forecast may one day be ours. As yet it eludes us. The periods of protracted drought have been in general from 5 to 12 years, and periods of greater rainfall range from one to five to 60 or more years in duration. There are marked differences in cycle phase from region to region. One region may be wet, another dry, in a given year or period. Precipitation in the mountainous areas of the West is in closer correspondence as to amounts and times of occurrence than the lighter precipitation on the adjacent plains and basin floors.

One can safely predict for our dry West a rainfall heavier than that of the present. One can also be reasonably sure that its return is near, a matter of a few years at most, for the longer a drought lasts the surer we are (from past records of duration) that it will soon end. The less extreme rainfall departures are local, and that means locally different; the more extreme departures affect wider territory; and the most extreme affect most of the West and the Great Plains. It is the last-named type that we have been experiencing.

Was the West ever as dry as it is now? The rainfall records west of the 100th meridian with few exceptions cover a period but 50 to 60 years in length. Accounts of lake levels, reports of the condition of the grass and the record of the differences in thickness of tree rings on adjacent slopes of the Great Basin combine to tell us that the most severe drought of that region, prior to the present one, as far back as any of the evidence goes, was in the 40's, with interrupted duration of drought from 1829 to 1852. Different parts of the region later on suffered shorter droughts at intervals. The changes in level of Goose Lake, lying across the California-Oregon boundary, are instructive. From the slides you see a part of its floor exposed and wagon tracks running across it. A track also shows across its southern end on one of the sheets of the Wheeler Survey of 1877–1878.

The disappearance of these tracks, made by the forty-niners and others, soon after progressive exposure in the period about 1920–1927, supports the presumption that they were quickly covered with water soon after the lake level rose (1852+) and were

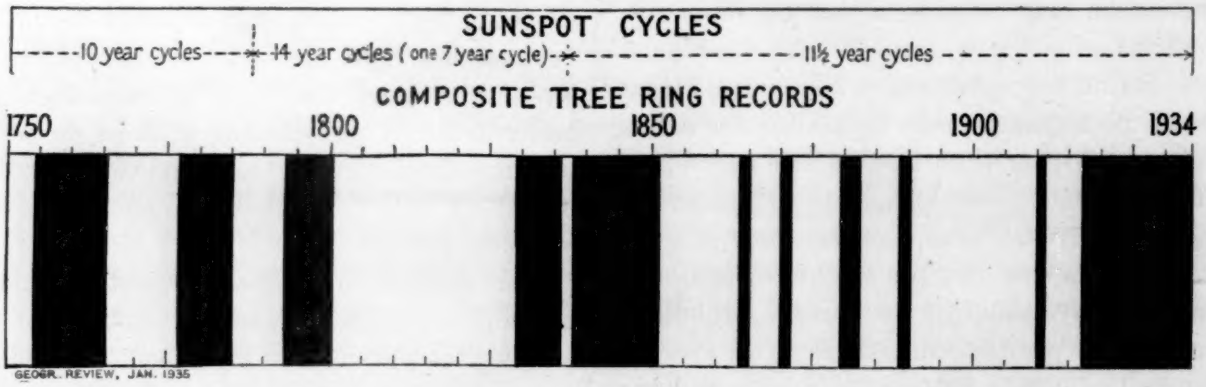

Fig. 6. Sunspot cycles and tree growth. In the upper part of the diagram are shown the dates of change in the lengths of successive sunspot cycles. The lower diagram is a composite representation of tree records in central Oregon and northeastern California. The shaded bands represent periods in which tree-rings are prevailingly thin, indicating lighter rainfall and a lower water table. Alternating blank-spaces represent periods of thicker tree-rings, greater rainfall and higher water table.

graphical Society with two supplementary grants from the Carnegie Institution. The results have been published in part in the *Geographical Review*. The present résumé is based chiefly on material in "Our Expanding and Contracting 'Desert,'" *Geogr. Rev.*, January, 1935, pp. 43–65. Dr. Antevs, who participated in the study, has just completed a paper to be published jointly by the American Geographical Society and the Carnegie Institution, entitled "Rainfall Fluctuations in the Great Basin during the past 100 years."

not again exposed until the 1920's. Since diversion of the tributary water for irrigation would exaggerate the effects of diminished rainfall on lake level, it is safe to say that the period between 1852 and 1918 was at no time so dry as in the late 1840's and since 1918. This conclusion requires checking, region by region, to determine the extent of its application to the West generally and to the Great Plains. The Goose Lake records are supported by the record of ring thicknesses in junipers in the Harney Lake region.[12]

Is there a general tendency toward increasing dryness? The present drought appears to be the *longest* that is recorded in the tree rings of the past two centuries, though such rings tell us almost nothing about proportional amounts of rainfall. It is, however, roughly like the drought of the 1840's in duration and possibly in intensity. We have no specific evidence that protracted droughts are now more frequent or severe than they were a century or two centuries ago. Glacier retreat may or may not indicate progressive desiccation. Much depends upon the seasonal distribution and kind of precipitation that affects glacier alimentation. There is no direct correlation between rate and amount of ice retreat on the one hand and precipitation on the other.[13] Highly important is the fact that mountains and plains may differ markedly in precipitation trends in the same period of time, and as yet we lack "normals" sufficiently reliable to use in determining the value of departures, in our search for a basis of forecast. The longest continuous rainfall record in the United States is 121 years (New Bedford, Mass.), too short to give us satisfactory evidence on secular changes in rainfall. Only uninformed boldness, not science, would venture long-range prediction as to future occurrence, duration and intensities of drought upon so short a record. One may safely predict a wetter future period than we have had for the past five years. In any event, we can not hurry the seasons. A closer spacing of rain gauges is possible and a further analysis of tree rings based on contemporaneous studies of tree growth in relation to local factors of insolation, rainfall pattern, etc.

Has our western land been permanently disabled? The "forces of life" have a curious way of offsetting or ridiculing our prophecies. Nature surprises us with her hardships and disasters but also with her beneficences. Her time schedule in many categories of action seems to be made up only a little way ahead. There is in preparation an "Atlas of Calamities." An essay should accompany it entitled "Calamities that never happened." A major query for the wind-eroded risk areas in the grasslands of the Great Plains is, "Under what conditions can a sod cover be restored?" With the breaking-up of the sod cover there is a tremendous increase in the action of rainwater, not in the way of direct erosion on flat surfaces, but in decreasing the crumb structure and porosity of the soil and destroying the humus content which acts as a binder. Repeated cultivation of the surface mulch on a fallow field—part of the process of dry-farming—hastens these processes and gives the wind a chance to carry the whole surface layer away. Thus thousands of farmers become "subsoil farmers."[14] If we change our cultivation habits, allow the land to remain idle, sow suitable grass seed and prohibit all grazing for a time, we shall find out how far and how fast a sod cover can be restored. These things are also likely to show whether or not irreparable damage to the soil has been done because of a lack of favorable rainfall in our present phase of rainfall change and how far we may expect early replacement of a grass cover.

The list of inquiries might be greatly extended. I have chosen to limit myself to four of the main or immediate questions: much might be added on water resources and wild life conservation, and on economic questions in their regional framework. The adaptable techniques of science that will aid in the wiser use of our drier lands are not difficult to apply: it *is* difficult to get short-term administrators to see their importance. Government is now so large and complicated that small and temporarily powerful groups may control decisions on grave issues, scientific and administrative, and the heads apparently have to be too much occupied politically to give attention to well-coordinated scientific programs. Scientific research is too often left to the mercy of rival bureaus and to the decisions of ambitious men who are engrossed in personal advancement.

Four leading desiderata in a land-use program for the semiarid areas of pronounced risk may be mentioned in closing: (1) soil erosion techniques should be tested by research upon the present widely developed field projects; (2) the principal wind-erosion districts of the Great Plains should be withdrawn from cultivation, and experiments and studies instituted looking toward the restoration of a sod cover to be followed by grazing under strict regulations; (3) tree and shrub plantings should be limited to the better parts of the shelterbelt, the expected beneficial effects being in the longer future, while cultivation practices both in and out of the shelterbelt need immediate improvement from the wind-erosion and agricultural-risk standpoints; (4) a thoroughgoing analysis of climatological records should be made to help determine and define the areas and grades of serious agricultural risk.

[12] L. T. Jessup, *Geog. Rev.*, 25: 310–312, April, 1935.

[13] The Committee on Glaciers of the American Geophysical Union has found that the glaciers of the United States have been in retreat since a time before 1850. If the retreat continues, most of the glaciers of our western ranges will have disappeared, as they are believed, on physiographic evidence, to have done a few centuries ago.

[14] H. H. Bennett, Science, April 5, 1935, p. 322.

OBITUARY

ELBERT WILLIAM ROCKWOOD

WHILE waiting for the train that was to carry him on a vacation to his beloved New England, Professor Elbert William Rockwood died suddenly of a heart attack on July 17, 1935. He was born at Franklin, Massachusetts, on July 4, 1860, the son of William and Laura (Blake) Rockwood. He received his B.S. degree from Amherst in 1884. During the three years following his graduation he was successively instructor in chemistry at Wesleyan University and Cornell University, and chemist at the Hatch Experiment Station, Connecticut. He went to the University of Iowa as professor of chemistry and toxicology in 1888. In 1904 he became the head of the department of chemistry, and he held this position until 1920, when he retired as professor of chemistry to devote his time to teaching and to his favorite field of research.

He was a graduate student at the University of Göttingen in 1889; University of Strassburg, 1890–1891; University of Leipzig, 1892 and 1894; University of Chicago, 1893. His degrees include an M.D. from Iowa in 1895, an A.M. from Amherst in 1901 and a Ph.D. from Yale in 1904.

Dr. Rockwood was a member of Phi Beta Kappa, Sigma Xi, the American Chemical Society, the German Chemical Society and the American Society of Biological Chemists. Among his numerous publications are two books—"A Laboratory Manual of Physiological Chemistry" and "Introduction to Chemical Analysis for Medical Students."

Upon going to Iowa, Dr. Rockwood was placed in charge of students of medicine and dentistry. That this was not an easy task will be readily admitted by the honest and sincere, yet lusty, vigorous, boisterous, fun-loving students of those early days. The real genuine interest which he has always taken in his students was quickly recognized and won for him then, as since, the lasting loyalty and friendship of his students.

He went to Iowa when the department of chemistry was in its infancy; throughout the whole of his régime economy was the watchword; funds for equipment and instructors were low. The teaching staff was necessarily small and the teaching schedule was heavy. He never shirked his part, but always bore his share of the teaching load. He made the most of the conditions as they were. Imbued with the conviction that the best and most mature instructors were none too good for the students, he employed only full-time instructors. The efforts which he made were reflected in the attitude and the work of the students. They, too, buckled down to serious, conscientious work. At the side of the student in the laboratory Dr. Rockwood had few equals in imparting knowledge and methods of technique.

Dr. Rockwood took with him the traditions and the ideals of the old colleges of the cultured East and of Germany. He took also the idea that scientific chemical training, if it is to be most fruitful, must go hand in hand with culture. He has stood for scholarship among chemists, for quality rather than quantity.

In spite of the heavy burden of his work he found time to read widely in all fields. He kept pace with the most important advances in pure and applied chemistry. His knowledge and grasp of theoretical chemistry outside his particular field has always been a source of wonder and amazement to his colleagues.

An enthusiastic and conscientious teacher himself, he was always sympathetic and generous toward the efforts of others. His attitude was a source of inspiration and encouragement to younger men entering the teaching profession. He always sought the advice and suggestions of his more mature instructors and, whenever possible, he incorporated these into the work of the department.

His office door has always swung open to student and instructor alike. He was never too busy to stop his work and chat upon things worth while; never too busy to give advice and encouragement. Whenever it was necessary to admonish or to bear down, he did that also, but always in an open and gracious manner that left no sting. The one admonished may have left his office somewhat sorry, saddened and sobered, perhaps somewhat angry at the time, yet in the twenty-eight years I have been associated with Dr. Rockwood I have never known a student to leave his office as an enemy.

He always looked upon our special students and graduates in chemistry as his boys, and his interest in them has continued long after their graduation. How often he has come to me with these words, his face all smiles: "Do you remember Mr. ———, way back there? I just received a letter from him. He is doing fine. I knew that he would."

In recent years I have had frequent occasion to run through his card index containing the names and addresses of all our chemistry graduates—the mailing list of his much cherished *News Letter* to the alumni of the department. Many of these cards are old and somewhat frayed; they are covered with finger prints. These cards had become to him a rosary, a string of pearls over which he has pondered long and affectionately; each card a pearl, each pearl a student in whose success he has played a part.

It is these qualities in Dr. Rockwood, together with his culture and refinement, his fairness and generosity,

his humility, his love for all that is good and worth-while in life, in the arts and in music, that have endeared him to the alumni of the department and to the university. Forty-seven years—an academic life-time spent in active service in one department. Relatively few have served longer, more faithfully or better. Relatively few have taken the work and the welfare of the student more closely to heart.

J. N. PEARCE

RECENT DEATHS

DR. CARL BARUS, professor of physics at Brown University from 1895 until his retirement in 1926, and dean of the university's graduate department for twenty-three years, died on September 20. He was seventy-nine years old.

DR. KEITH KUENZI SMITH, associate professor of physics at Northwestern University, died on September 17 in his forty-eighth year.

DR. WALTER HOUGH, who joined the department of anthropology of the U. S. National Museum in 1886 and who has been head curator since 1923, died on September 20 in his seventy-seventh year.

DR. CHARLES HENRY RICHARDSON, professor of mineralogy and geology and director of the Natural Science Museum at Syracuse University, died on September 19 at the age of seventy-two years.

DR. CLIFFORD H. ALVEY, assistant professor of zoology at Purdue University, died suddenly on September 10.

DR. JOHN P. HYLAN, assistant professor of psychology at the University of Illinois from 1898 to 1899 and assistant in philosophy at Harvard University from 1900 to 1905, died on August 30 at the age of sixty-five years. Dr. Hylan on account of ill health gave up teaching to become a dairy farmer.

SCIENTIFIC EVENTS

THE LONDON SCHOOL OF TROPICAL MEDICINE

AT the annual meeting of the court of the London School of Tropical Medicine a letter received from Sir Austen Chamberlain, chairman of the Board of Governors, referred to the incorporation in the school of the Ross Institute, which opened much larger opportunities for the practical application of the scientific results obtained in the laboratories and made available all the resources for study and research and for further developing the prevention and cure of tropical disease. Referring to the fact that the accounts had been balanced hitherto only by an extraordinary grant from the Rockefeller Foundation, which had now finally ceased, he said: "We owe to the large-minded generosity of the Rockefeller Foundation the fine block of buildings in which the school is carried on and a site in the center of the university quarter. It has further helped us to tide over the difficult years which followed on the world economic crisis, but our main source of income is the grant received through the university from the government in recognition of the Imperial importance of the work of the school. To supplement this grant we make our appeal to other governments of the empire and to corporations and private traders who derive advantage or profit from our labors. Surely when they know what these labors have achieved, and how much more is still to be done, their help will not fail us. In the past year we have received two splendid contributions—Mr. W. J. Courtauld, to whose generosity we already owed so much, has sent us a further sum of £16,000 to complete the endowment of the chair to which he allowed us to attach his name, and the Nizam of Hyderabad sent us a donation of £2,000, which we hope will become the nucleus of a new endowment."

Dean W. W. Jameson, presenting the annual report, said they had had 173 full-time students. That very large number was 26 more than in any preceding year. They came from 20 different countries, and on taking their degrees had proceeded to appointments in 26 countries. They had also had a considerable number of foreign students for short-term courses.

THE ENLARGED CHEMISTRY BUILDING OF THE UNIVERSITY OF CALIFORNIA AT LOS ANGELES

THE construction of the new south wing completes the chemistry building of the University of California at Los Angeles. This addition rounds out the quadrangle group constituting the main academic buildings.

As described in *Industrial and Engineering Chemistry*, the building is of Mediterranean Renaissance type. The earthquake hazards of brick structures were realized from the first, so that it does not depend for fundamental support upon brick.

The new south wing, with several large classrooms in which pillars were not admissible, was constructed in "Class A" style with full steel frame and reinforced concrete, again using brick face and tile partitions. The whole combined structure accounts for a total of nearly 1,400,000 cubic feet, and cost approximately $800,000, including all built-in scientific equipment. The low cost of 58 cents per cubic foot is explained by the fact that a mild climate permits great economies

without sacrifice in real quality. Even the new wing, with its 17 miles of electrical conductors and other equipment to match, was installed at only 60 cents per cubic foot, but of course under more favorable market conditions.

The older portion of the building houses not only the administrative offices, storerooms, central mechanical services, library, etc., of chemistry, but also includes the large laboratories in elementary and advanced inorganic and organic chemistry and biochemistry. The new wing houses quantitative analysis and physical chemistry on two of its floors. The feature of this section is a sub-basement underlying the whole southerly block. This part is subdivided into ten research laboratories, all with complete forced-ventilation service. The subterranean location practically eliminates the considerable day-to-night temperature variation characteristic of California. Like the instructors' private laboratories, these research laboratories are equipped with gas, water, steam, air, vacuum and diversified electrical service. In addition to the conventional single- and 3-phase alternating current, and generator-battery direct current services, a very useful multivoltage, 1 to 220 volt alternating current service is provided at a central transformer. Lights, students' laboratory circuits, etc., are protected by individual circuit breakers instead of fuses. The newer classrooms, offices and corridors are treated with acoustic plaster.

THE NEW ARBORETUM OF CORNELL UNIVERSITY

PROFESSOR RALPH W. CURTIS gives an account in *The Cornell Alumni News* of the beginning of the work on the new arboretum to be constructed at Cornell University. Unlike any other great arboretum or botanic garden, this one will be not only a garden of trees, shrubs and vines brought together for scientific purposes, but in addition will exemplify the principles of landscape design and be a laboratory for the conservation of wild life. None of these three ideas is new in itself, but their combination into one great preserve is a novel enlargement of the arboretum idea. The arboretum will occupy eventually more than five hundred acres of present university property.

The landscape consultant is Nelson Wells, '18, now with the Department of Parks, New York City. The chairman of the university arboretum committee is Conant Van Blarcom, '08, superintendent of Cornell buildings and grounds; the other members are Professors Gilmore D. Clarke, '13, planning; Carl Crandall, '12, civil engineering; Ralph W. Curtis, '01, ornamental horticulture; Ralph S. Hosmer, forestry; Eugene D. Montillon, '07, landscape architecture, and Karl M. Wiegand, '94, botany. Lieutenant R. D. Blanchard of the army is construction officer of the camp, and Charles E. Houghton, of the Finger Lakes State Park Commission project, is project superintendent in charge of the whole arboretum development.

Eight general provisions adopted by the management of the arboretum are announced:

1. The arboretum should contain representatives of all species and varieties of woody plants which will grow in this climate.

2. The arrangement of plants in the arboretum should be such as to give the best landscape effects and also promote to the highest degree their educational value.

3. The wilder areas should be maintained as nearly as possible in their natural condition.

4. Areas needed for special biological purposes may be assigned when this seems desirable. Such areas should be brought into harmony, as far as possible, with the general scheme of the arboretum.

5. Local characteristic trees, shrubs, and vines should be planted generously and quite continuously as the background of the arboretum to give continuity and appropriate setting for the large amount of exotic planting which the arboretum will contain.

6. The planting scheme of the arboretum should be a composite of four superimposed seasonal units so that at all times of the year, in spring, summer, autumn, and winter, there will be interest throughout the entire arboretum.

7. While the planting should be in generic groups, so that any one may find the oaks near each other and the maples, pines, and other groups in the same fashion, the scenic appearance of the arboretum must be maintained by merging the individuals in adjacent groups so that they tie together with the background material and those plantings made for seasonal interest. In this way the arboretum will demonstrate planting design as well as plant materials.

8. Circulation should be by paths and by only such roads as are necessary for accessibility and service. Entrances, in location and number as necessary and desirable, should be established to connect the arboretum with adjoining roads. By this plan, it is hoped that the Cornell Arboretum may become distinctly a plant sanctuary.

A CCC camp of two hundred workers has been transferred to Ithaca to carry on the work.

THE HAYDEN PLANETARIUM OF THE AMERICAN MUSEUM OF NATURAL HISTORY

THE Hayden Planetarium at the American Museum of Natural History will open its doors to the public on October 3, when a group of school children will comprise the audience. It is expected that at least 300,000 children will attend free of charge in the course of each school year. The work is being done by the museum in cooperation with the City School Department.

There will be six public performances a day. One at 11 o'clock in the morning, then again at 2, 3, and 4 o'clock in the afternoon, and two performances at night—one at 8, and one at 9 o'clock and, for the time being at least, five public Sunday showings at the same afternoon and evening hours. Each presentation will last from 35 to 40 minutes, with a lecturer to explain the movements of the stars.

The Hayden Planetarium, made possible through a gift of $150,000 from Charles Hayden and through funds loaned by the R.F.C., is a two-story structure erected at a cost of $650,000. It has a dome-like roof which supports the semispherical projection ceiling in the auditorium on the second floor. The building was designed by Trowbridge and Livingston, and was built by the White Construction Company. The Zeiss Optical Company supplied the instruments for the planetarium.

The officers of the Planetarium Authority, of which F. Trubee Davison is president, are: Daniel E. Pomeroy, *first vice-president;* Cleveland E. Dodge, *second vice-president;* E. Roland Harriman, *treasurer,* and Clarence L. Hary, *secretary.* They are also members of the Executive Committee, together with Junius S. Morgan, H. Rivington Pyne, A. Perry Osborn and Robert Moses.

The administrative officers are: Roy Chapman Andrews, *director;* Dr. Clyde Fisher, *curator;* Wayne M. Faunce, *vice-director* and *executive secretary,* and Frederick H. Smyth, *bursar.*

The planning and building of the Planetarium were aided by an advisory committee made up of the following: A. Cressy Morrison, *chairman;* H. Rivington Pyne, Charles J. Liebman, O. H. Caldwell, John A. Kingsbury, John M. Morehead, John I. Downey, Henry Norris Russell, George Ellery Hale, Samuel Alfred Mitchell, Harlow Shapley, William A. Chadbourne, S. L. Rothafel, Duncan H. Read and Wallace W. Atwood.

Dr. Clyde Fisher, curator of astronomy, will be the active head of the Planetarium, with William H. Barton, Jr., as associate curator. The following assistant curators are on Dr. Fisher's staff: Marian Lockwood, Dorothy A. Bennett, Arthur L. Draper. Charles A. Federer, Jr., will be one of the guest lecturers.

Under the terms entered into with the R.F.C., the cost of building was financed through the issue of $650,000—twenty-year Reconstruction Finance Corporation bonds at 4½ per cent. Under the rules imposed by the federal government all income, except actual operating costs, must be turned over to the R.F.C. It is tentatively proposed to charge 25 cents admission for morning and afternoon performances and 35 cents at night.

SCIENTIFIC NOTES AND NEWS

DR. ALBERT N. JORGENSEN, professor in the School of Education at the University of Buffalo, has been elected president of the Connecticut State College at Storrs.

DR. WILLIAM T. ROOT, JR., professor of educational psychology and head of the department, has been appointed dean of the Graduate School of the University of Pittsburgh. He will continue as head of the work in psychology. Dr. E. R. Weidlein, director of Mellon Institute, has been acting dean of the Graduate School since the resignation of Professor L. P. Sieg to become president of the University of Washington.

DR. CHAIM WEIZMANN, the newly elected president of the World Zionist Organization, director of the Agricultural Experiment Station at Rehoboth in Palestine and president of the Hebrew University at Jerusalem since its inception, has been named chairman of the board of governors of the university. He is succeeded as president by Dr. Judah L. Magnes, who had previously filled the office of chancellor.

WITH the opening of the new college year Professor Stanhope Bayne-Jones, professor of bacteriology in the faculty of medicine, assumes the deanship of the Yale School of Medicine, in succession to Dr. Milton C. Winternitz, who resigned at the end of the college year.

DR. THOMAS S. BAKER, since 1922 president of the Carnegie Institute of Technology, Pittsburgh, Pa., has retired from active service on account of ill health. At a meeting of the Board of Trustees on September 17 the title of emeritus was conferred on him and he was nominated for membership on the board. Until a successor is selected, Dr. Charles Watkins, director of the Margaret Morrison Carnegie College, will continue as acting president. In announcing the retirement of Dr. Baker, Samuel Harden Church, president of the board of trustees, said: "The board has acted upon Dr. Baker's wish for retirement with a most profound regret, all the members feeling what this step would mean as a loss to the educational interests of Pittsburgh and the world at large. During the time that Dr. Baker has occupied the presidency of Carnegie Tech he has deepened the resources of its scholarship and expanded its influence until it is now recognized as one of the world's great engineering schools. Dr. Baker has made Carnegie Tech practically a great reservoir for the advancement of scientific knowledge, particularly in the development of metal-

lurgy in all its branches and in the knowledge of coal and its by-products to the uses of industry."

AT the meeting of the American Psychological Association held in Ann Arbor on September 6, the following testimonial, engrossed on parchment and signed by Professor Albert T. Poffenberger, president of the association, and Professor Donald G. Paterson, secretary, was presented: "We, members of the American Psychological Association, present this testimonial to James McKeen Cattell, a founder of the Association and its president forty years ago, in grateful appreciation of his distinguished services to Psychology. We honor him for his eminent achievements in experimental psychology, mental measurement, and the scientific analysis of individual differences. We are grateful for his services to psychology through this Association, for the journals which he has founded and edited, for his contributions to the establishment of psychology among the sciences, and for his devotion to the cause of science in general." The testimonial was presented *in absentia,* as Dr. Cattell was attending the seventh American Scientific Congress in Mexico City, as delegate of the United States Government and of the National Academy of Sciences, the American Association for the Advancement of Science and the American Psychological Association.

AT a meeting of the general committee of the British Association on September 6, at which Sir Josiah Stamp was elected president, additional appointments were made as follows: Professor P. G. H. Boswell was appointed to replace Sir Josiah Stamp as general treasurer; new general secretaries, F. T. Brooks and Professor Allan Ferguson. Six vacancies on the council were filled by the election of Lord Bledisloe, Professor Fearnsides, Professor R. Robinson, Sir Gilbert Walker, Dr. Julian S. Huxley and Dr. Tierney. The association will meet at Blackpool in 1936.

AT the San Francisco meeting of the American Chemical Society, E. P. Kohler, of Harvard University, was reelected associate editor of the *Journal* of the society, and Professor F. C. Whitmore, of the Pennsylvania State College, was also elected an associate editor. W. A. Schmidt, of Los Angeles, Dr. E. R. Weidlein, director of the Mellon Institute, Pittsburgh, and F. C. Zeisberg, of Wilmington, Del., were reelected associate editors of Technologic Monographs, and Carl S. Miner, of Chicago, was elected to fill the unexpired term of the late A. D. Little on that board. Professor H. B. Weiser, of Rice Institute, Houston, Texas, and Professor T. R. Hogness, of the University of Chicago, were elected for a two-year term, beginning on January 1, 1936, as associate editors of the *Journal of Physical Chemistry.* Walter A. Schmidt, of Los Angeles, was elected for a term of three years, as a member of the council committee on policy.

DR. FRANKLIN J. BACON, professor of pharmacognosy at Western Reserve University, has been elected president of the Plant Science Seminar. The seminar was organized by the University of Minnesota in 1923 to promote interest in medicinal plants, vegetable drugs and food products. It will have its annual meeting next July in Portland, Ore.

MILES E. CARY was elected president and Dr. Roswell H. Johnson, formerly of the University of Pittsburgh, executive secretary, of the Social Hygiene Association of Hawaii, which was organized on August 21 in Honolulu.

DR. BRADLEY MERRILL PATTEN, assistant director of the medical sciences at the Rockefeller Foundation, has been appointed professor of anatomy and director of the anatomical laboratories at the University of Michigan. Professor Patten will be on leave of absence for the first semester of the university year, 1935–1936.

DR. WOLFGANG KOEHLER, formerly head of the Psychological Institute at the University of Berlin, has been appointed visiting professor of psychology at Swarthmore College. He will conduct seminars in systematic psychology and in the philosophical implications of modern science.

PROMOTIONS at Northwestern University include: Dr. Oliver J. Lee, chairman of the department of astronomy and director of Dearborn Observatory, from associate professor to professor; Malcolm Dole, from instructor to assistant professor of chemistry; Dr. Charles H. Behre, Jr., chairman of the department of geology and geography, from associate professor to professor; Dr. Walter S. Huxford, from assistant professor to associate professor of physics. The following new appointments have been made: Arthur R. Sayre, instructor in astronomy; P. W. Selwood, instructor in chemistry.

DR. ROY K. MARSHALL, who was for eighteen months a lecturer at the Adler Planetarium and Astronomical Museum of Chicago and who was engaged in research at the Yerkes and Harvard College Observatories last winter, has been appointed instructor in astronomy and mathematics at Wilson College, Chambersburg, Pa.

VISITING lecturers at Harvard University this year include Dr. Leonard Carmichael, professor of psychology at Brown University, in psychology, and Dr. Rudolph E. Langer, of the University of Wisconsin, and Dr. Lars V. Ahlfors, of the University of Helsingfors, in mathematics.

DR. CHARLES F. MCKHANN, assistant professor of pediatrics and communicable diseases at the Harvard Medical School, Boston, has been appointed visiting

professor of pediatrics at Peiping Union Medical College during the first half of the school year 1935–36. He will return to Boston early in March, 1936.

DR. JOHN ALFRED RYLE has been appointed Regius professor of physic in the University of Cambridge in succession to Sir Walter Langdon Brown, who will retire on September 30.

DUNCAN MACCALLUM BLAIR, professor of anatomy and dean of the medical faculty, King's College, University of London, has become Regius professor of anatomy in the University of Glasgow, in the place of Professor T. H. Bryce, whose resignation takes effect on September 30.

THE leave of absence of Dr. Erwin E. Nelson, of the University of Michigan, has been extended to permit him to complete his task of reorganizing the enlarged pharmacological laboratory of the Food and Drug Administration of the U. S. Department of Agriculture.

UNDER a fellowship of the John Simon Guggenheim Foundation of New York, Dr. T. H. Goodspeed, professor of botany and director of the Botanical Garden of the University of California, will spend the months October to February collecting species of *Nicotiana* and related genera in Peru, Chile, Bolivia and Argentina. Accompanying Dr. Goodspeed as collector will be James West, of San Rafael, and Mrs. Ynes Mexia, collector in Central and South America, will join the expedition at Lima. Most of the collecting will be done in higher altitudes of the Andes, but it is anticipated that certain members of the expedition will collect south of Santiago, crossing the Andes in the Chilean lake region and continuing through the Patagonian pampas to Buenos Aires.

DR. HAMILTON FAIRLEY, secretary of the Royal Society of Tropical Medicine in London, is planning a visit to the United States to address the annual meeting of the American Society of Tropical Medicine, to be held in St. Louis from November 20 to 22. He will go first to San Francisco, making his first appearance before the San Francisco County Medical Society on November 13. The following day he will address the Pasteur Society, and on November 15 he will address the students and staff of the University of California Medical School.

THE eleventh International Congress of Psychology will be held in Madrid from September 6 to 12, 1936.

THE American Association of Agricultural College Editors has voted to hold its annual meeting in the summer of 1936 in Wisconsin, probably at the university. The association, first formed in 1913, held its last conference in Wisconsin in 1915.

AT the invitation of the American Association for the Advancement of Science, the United Chapters of Phi Beta Kappa, an affiliated society, has arranged to sponsor a lecture at the winter meetings of the association. This lecture is intended to symbolize the cultural value of science and the interest of scientific men in the humanistic relations of their research. The first of the annual Phi Beta Kappa lectures will be delivered at the St. Louis meeting at a general public session on Wednesday evening, January 1, 1936. The speaker will be Dr. Frederick J. E. Woodbridge, Johnsonian professor of philosophy at Columbia University, formerly dean of the faculties of political science, philosophy, pure science and fine arts. The subject of the lecture will be "The Claims of Science."

A CONGRESS of the Association pour la Documentation Photographique et Cinématographique dans les Sciences will be held in Paris from October 4 to 11. It is planned to exhibit radio-cinematographic films of organs synchronized with the sounds produced by them and scientific films in direct color.

A CELEBRATION of the three hundredth anniversary of the founding of the Royal Hungarian Peter Pazmany University was held in Budapest from September 15 to 29. The program included a conversazione, a Te Deum in the university church, a visit to the central building of the university, an exhibition in the library and a performance in the Royal Opera House. Honorary degrees were conferred and there was a reception by the Minister of Education. There were, in addition, the usual sight-seeing trips and excursions.

IN connection with the Centennial Central Exposition to be held in Dallas in 1936, in celebration of the 100th anniversary of the independence of Texas, it is proposed to erect on the exposition grounds the first unit of a natural history museum to cost approximately $300,000. The project is sponsored by the Texas Centennial Central Exposition, a corporation, and is being directed by George L. Dahl, architect and chief of the technical division. The exposition will open next June.

BY the will of Mrs. Anna Phipps Tinker, nearly the entire estate, amounting to over $200,000, will go eventually to the children's medical division of Bellevue Hospital, New York City, in memory of Dr. Horace H. Tinker. Mrs. Tinker's will, setting forth that most of the property had come from him, stated: "He loved children and was glad to give his services without compensation to needy children during his lifetime."

BY the will of the late William Charles Gotshall, Lehigh University and Union College, Schenectady, N. Y., each receive two tenths of the residue of the estate, and Washington University, St. Louis, and

Rensselaer Polytechnic Institute each receive one tenth.

THE first number of a new quarterly, *Annals of Science,* devoted to the history of science since Renaissance times, will be published by Messrs. Taylor and Francis, London, on January 15, 1936, under the editorship of Dr. D. McKie, of University College, London, joint author of "The Discovery of Specific and Latent Heats"; Professor Harcourt Brown, of Washington University, St. Louis, author of "Scientific Organizations in Seventeenth Century France," and H. W. Robinson, librarian of the Royal Society of London, coeditor of "The Diary of Robert Hooke."

THE London *Times* reports that The Institute of Chemistry of Great Britain celebrated at a dinner held in London recently the completion of fifty years' existence under Royal Charter. The institute was founded in 1877 as "the result of a long pent-up feeling of dissatisfaction, particularly among the younger fellows of the Chemical Society, at the deficiency of means for chemists to exert a common action and influence," and the primary object of its formation was to ensure that those who practised the profession of chemistry were duly qualified for the proper discharge of the duties they undertook, by the thorough study of chemistry and allied sciences and of their application to public health, agriculture, the arts, industries and commerce. Sir Edward Frankland was the first president. The institute became incorporated under Royal Charter on June 13, 1885, and acquired the right to confer definite qualifications—A.I.C. and F.I.C. The register of the institute now includes the names of over 6,300 fellows and associates practising in all parts of the Empire, and of about 800 students who are in course of preparation for the profession of chemistry. Local sections have been established in twenty areas, including the Cape of Good Hope, New Zealand and Malaya.

Nature writes: "The Australian National Research Council, having come to the conclusion, at a general meeting last January, that it is not properly fulfilling its function as a national body representative of scientific thought and endeavor, will, during this year, examine the possibilities of effecting a federation of the various State Royal Societies, the Linnean Society of New South Wales and a number of professional organizations such as the Australian Chemical Institute, the Institute of Physics, the Institution of Engineers and the Australian Veterinary Association. The federation will be confined to bodies concerned with the physical and biological sciences. No constitution has yet been suggested, but the general proposal is that each constituent member shall retain its independence as at present and shall have the right to representation on the Federal Council. The nature of the representation and the definition of duties of the council will be the subject of discussion at a conference of delegates from the interested societies, to be called later by the present National Research Council."

DISCUSSION

VITALISM, IRRITABILITY AND PERPETUUM MOBILE

BLACKMAN[1] has called attention to the fact that our general terminology of irritability, stimulus and response has no basis in physical or chemical mechanics. The history of the development of the concept of irritability shows that it was built up in such a way as to make any such basis not only unnecessary but undesirable. It is not surprising, then, that frequently we should find ourselves in difficulty when we try to express some of these concepts in mechanical terms. One such difficulty is the postulate of perpetual motion which is often implied when we attempt to describe the simultaneous action of two or more different agents upon the same tissue or organism. When we remember that physicists as well as laymen believed in the possibility of perpetual motion at the time when the terminology of irritability was developed, we need not be surprised at its persistence in our heritage of dialectics, which still constitutes an orthodox part of physiology, pharmacology, psychology, and psychiatry, and others unnamed.

There is a general implication that irritability is in inverse ratio to the quantity of work which is necessary to elicit a reaction in an organism or tissue. The irritability is said to be high when the work necessary to stimulate is low. Thus, the irritability of a tissue requiring only 1×10^{-7} ergs for its stimulation is greater than that of a tissue requiring 1×10^{-4} ergs for excitation. Provisionally we may say that

$$I = \frac{1}{W},$$

where I is the irritability and W the quantity of work necessary to stimulate. Irritability may be expressed as the reciprocal of the work.

If W is the work necessary for stimulation, done by an electrical current, e.g., under control conditions, then some other agent acting upon the tissue may

[1] F. F. Blackman, *Nature,* 78: 557, 1908; *American Naturalist,* 42: 637, 1908.

reduce the amount of work necessary to stimulate done by the electrical current while the second agent is acting. The usual statement in such a case is to the effect that the second agent has increased the irritability of the tissue in question. There is a general reluctance in some quarters to consider, or admit, that the second agent has done any work on the tissue. Consider the consequences of the denial that the second agent has done any work on the tissue.

Under control conditions, a quantity of work W is necessary to stimulate while, under the second set of conditions, a quantity of work W_1 less than W is sufficient. Then, without doing any work upon the system represented by the tissue, but merely by increasing its irritability, we have induced a change of state such that the application of a smaller amount of work applied to the system in the form of a stimulus gets the same amount of work out of the system as before. That is, we have somewhere gained work without any corresponding expenditure of work. Such a condition would constitute a veritable perpetuum mobile.

It does not seem necessary, however, to postulate perpetual motion in biological processes. If we were to proceed on the assumption that some principles of mechanics, physical or chemical or both, apply even in irritability, we would suppose that our second agent, say a drug, which, by itself, will not produce any typical excitation of the given tissue, would do work W_d upon the tissue. The work done by the electrical current now need be only W_e, less than W. Our equation would become

$$I = \frac{1}{W_e + W_d},$$

in which $W_e + W_d$ might be equal to, or even greater than, W. (The inequality of $W_e + W_d$ and W would arise from the fact that the action of drugs is not 100 per cent. efficient thermodynamically.) Neither total quantity of work nor irritability need change.

A physical analogy might be a rock in the air, but so situated that it might be completely surrounded by water at will. A quantity of work x would be necessary to raise the rock when in the air, but only x–y units of work would be necessary when it was in the water. The water would not raise the rock by itself, but it would do y units of work on the rock.

Neither the total quantity of work nor the irritability of the rock need change. The converse of this case is also true. If the rock were originally surrounded by water which could be pumped off or drained off by the fall of the tide, more work would be necessary to raise it in the air. But we need not postulate any decrease of irritability in the rock. Nor would we say that the presence or absence of water added to or subtracted from the "levitation" in the rock.

We would probably get along faster and acquire somewhat clearer ideas of the processes involved if we were to consider the general case of two or more agents acting simultaneously upon a tissue or organism from the point of view of work done upon the system, even though our measurements at present are inadequate to give the notion quantitative exactness, than we would if we were to retain the seventeenth century concept of irritability and invent new words to show how the postulate of perpetual motion is to be avoided.

F. H. PIKE

COLUMBIA UNIVERSITY

THE EFFECT OF FLUORINE IN NATURAL WATERS ON THE TEETH OF SMALL FISH

THE world-wide dental distrophy known as "mottled enamel" has been definitely proved to follow the ingestion of drinking water containing small amounts of fluoride ion, during the formative period of the teeth.[1]

It has also been shown that the toxic concentrations of fluoride ion involved are of the order of one to five parts per million.[2]

It is difficult to get representative water analyses of fluoride ion at such low concentrations, and it is necessary to extend the analyses over a period of time to allow for variability in concentration. However, if small fish, found in practically all waters, should reflect in their teeth the average fluoride ion concentration of their habitat, they could serve as a criterion of fluoride ion concentrations.

With this aim in view, the teeth of *Gambusia affinis* (mosquito-fish) were examined from: (1) A region in which no mottled enamel had been reported in the children; (2) a region where mottling had been found; and (3) a region where the children showed severe cases of mottled enamel.

It was found that in passing from region 1 to region 3, the pulp cavities of the fishes' teeth became broader or wider in proportion to the length of the teeth, and the teeth took on an increasing "roughened" appearance, the roughening being extreme in some cases. In one section the teeth showed extreme wear, indicating a soft structure.

There thus seems to be a relationship between the amount of fluoride ion in a given water and the condition of the teeth of the fish living therein.

Fish are being raised in known concentrations of fluoride ion, and it is hoped that from them definite data will be available.

[1] M. C. Smith, *University of Arizona Tech. Bul. 45.*

[2] H. V. Smith, *Jour. Ind. Eng. Chem.*, Anal. Ed., 7: 23, 1935.

As an aid to further study along this line, small fish preserved in 10 per cent. formalin, from regions where mottled enamel is endemic, will be greatly appreciated.

Andrew Neff

California Institute of Technology

THE CYTOLOGY OF THE DIFFERENTIATING SPIRAL VESSEL IN RICINUS COMMUNIS

Although spiral vessels are probably considered the most commonplace elements in plant anatomy, I have been unable to find any detailed account of their differentiation. In spiral vessels the spiral thickening may extend uninterrupted throughout an entire developing internode. This continuity of the spiral appears comprehensible only if the spiral is laid down as a continuous unit, and is not a composite resulting from the fusion of spirals in vertically adjacent cells.

In *Ricinus communis* all stages of differentiation of the spiral vessels may be found. As soon as the future xylem elements, cut off from the cambium, begin to vacuolate, to expand and to elongate, the end walls of the vertically superimposed cells break down. The result is a coencyte traceable often throughout the entire length of the internode. The protoplasm is granular and is seen in all stages of vacuolation. The nuclei lie in vertical series numbering from ten to twenty and very often increase markedly in size. As is well known, the spiral thickening is laid down only when expansion is complete, and appears first as a faint unlignified cellulose band. Lignification follows, while protoplasm and nuclei remain intact and are observed in the fully differentiated element. The occurrence of the coenocytic phase of development explains the continuity of the spiral.

Further details of the process will be published shortly.

F. Murray Scott

University of California at Los Angeles

MOTION-PICTURE SPEED NOMENCLATURE

Does the translation of a simple, well-understood and widely used expression, "slow motion," into its Greek equivalent "bradykinetic" result in "a uniform terminology *which precludes confusion,*" as stated by Dr. Richards in Science for August 2, 1935, in the last paragraph of his article? Or does it result in the confusion evident in the immediately preceding paragraph, which states, "A '*bradykinetic*' film can not be obtained by *projecting* rapidly an 'isokinetic' film, *except within very narrow limits. . .*"

Now any one mechanically inclined knows one can not obtain a slow motion picture by speeding up the projector, as the effect would obviously be the opposite of that desired. Would not this error have been noted by the proofreader if it was not "Greek" to him?

If the number of frames per second projected be placed over the number of frames per second photographed and the word "actual-speed" be added an expression will result that will be self-explanatory and give all the desired information at a glance. Example: "This is a 16/256 actual-speed film." This obviously means a sixteenth speed film and that everything moves in the projected picture at one sixteenth the speed the actual objects did. In a 16/8 actual-speed film they move at twice the actual speed.

Martin A. Ryan

BIRCH-BARK CANOES

I have recently returned from Golden Lake, Ontario, where Indians still make birch-bark canoes for use, and sell them cheaper than factory-made canoes. They can make them for museum specimens without using such modern materials as nails.

Some museums may not know that such canoes are still made and available. Some owners of lakeside summer homes may not know that they can still get such canoes for use or merely as romantic lake-shore objects or lodge or dining-hall decorations, to be placed over mantels, etc.

I would be glad to help such museums and/or people to get in touch with Indians that I consider reliable, in order to help both parties concerned, especially as the Indian need of money and market would help keep alive a primitive North American industry.

Harlan I. Smith

National Museum of Canada,
Ottawa, Canada

SCIENTIFIC BOOKS

BIOCHEMISTRY

Annual Review of Biochemistry. Edited by James Murray Luck. Vol. IV, Annual Review of Biochemistry, Ltd., Stanford University P. O., California, 1935.

This "Annual," now in its fourth year, has already taken its place as one of those indispensable books without which a biochemical library is no library at all. We biochemists are deeply indebted to Professor Luck, the editor of all four volumes, upon whom rests the main responsibility of production. Instead of covering each year the fathomless ocean known as bio-

chemistry, Professor Luck has wisely decided to emphasize certain selected topics. Even then the contents, included within a volume of 639 pages, is bewildering. The topics discussed are permeability (Jacobs); biological oxidations and reductions (Sonderhoff); enzymes (Sumner); carbohydrates (Irvine and Robertson; Coris); acyclic constituents of natural fats and oils (Chargaff); proteins (Cohn; Kotake); sulfur metabolism (Lewis); purine chemistry (Cerecedo); fat metabolism (Artom); creatine and creatinine (Rose); detoxication mechanisms (Harrow and Sherwin); hormones (Houssay, Deulofeu and Marenzi); choline (Gaddum); vitamins (Harris); nutrition (Brody); muscle chemistry (Eggleton); metabolism of brain (E. G. Holmes); chemical embryology (Needham); biochemistry of malignant disease (B. Holmes); plant pigments (Kuhn); alkaloids (Robinson); minerals in plants (Steward); plant hormones (Thimann); immunochemistry (Heidelberger); and the chemistry of bacteria (Stephenson).

It must by now be obvious to the reader of this review that Luck has succeeded in getting reviewers who, for the most part, are in the front rank in their particular fields. Unfortunately, it does not always follow that the best critical reviews are thereby obtained. Very frankly, some of these articles—but happily a very small number—read like abstracts of *Chemical Abstracts,* reproduced with a complete lack of individual approach or critical appraisal. On the other hand, some of the reviews (I should particularly like to mention those by Irvine, Harris and Steward) might well serve as models for succeeding volumes. Nor can I resist the temptation, at this point, of referring to Rosenheim and King's matchless review of sterol chemistry which appeared in Volume III.

Aside from all this, for the reviewer to appraise critically the complete contents would indeed be presumptuous. Within the limits of his vision and his knowledge, the reading of this book has impressed him with a number of recent achievements. These may be gathered together in the form of the following statements: the importance of lyochromes and flavins in biological oxidations; a terminal methyl group oxidation of fats in addition to Knoop's β-oxidation; the further support of keto oxidation of amino-acids in the body by a study of tissue slices; the isolation, in crystalline form, of enzymes and zymogens; the synthesis of ascorbic acid; the influence of the pituitary and the adrenals in carbohydrate metabolism; the artificial production of the male and corpus luteum hormones; flavin as a constituent of vitamin B_2; the possible connection of vitamin B_2 and pernicious anemia; the intimate connection of phosphate with muscle activity; the "humoral transmission" at the nerve endings of the autonomic system; the production of methylcholanthrene, a carcinogenic substance, from deoxycholic acid, a bile acid; and β-indolyl-acetic acid as a plant hormone.

Impressed, also, is this reviewer with certain fields of biochemical research where, despite much activity, the results remain meager. I shall mention but three of these; the mechanism of insulin action; the creatine-creatinine situation; and the chemistry and metabolism of the brain.

Advances are often so rapid that we shall have to wait for the fifth edition for a record of some very recent achievements; such as the constitution of vitamin B_1 by Williams and Clarke; the synthesis of glutathione by Harington; the use of heavy hydrogen for the study of intermediate metabolism by Schoenheimer; the extensive use made by Bergmann and others of the former's elegant method for synthesizing various polypeptids; and the discovery of several male hormones by Ruzicka.

Benjamin Harrow
College of the City of New York

THE REPTILES OF CHINA

Natural History of Central Asia, Vol. X, The Reptiles of China. By Clifford H. Pope, American Museum of Natural History, 1935, liii + 604 pp., 78 ill., map, 27 pl.

The "difficulties and dangers" of faunistic work have been admirably met and coped with in Pope's splendid treatment of the 219 forms which make up the reptilian fauna of China. Four years of field work in China, seven months abroad examining Chinese material in European museums and assiduous study of the literature have enabled him to produce a work which is the best treatment of any reptilian fauna yet made and which immediately establishes the author in the front rank of living herpetologists.

The sixty-six lizards are considered in an annotated check list, with keys and synonymies. The twenty-two turtles and single alligator are given fuller treatment, and illustrated, either by new figures or by reproductions of those accompanying the original descriptions. The 130 snakes are given the same treatment as the turtles, with the addition of a great deal of very valuable and novel information on the maxillary dentition, the male sexual organ, sexual dimorphism, breeding habits, habitat and food preference. Wall's "Snakes of Ceylon" is the only comparable piece of ophiology, and Pope's treatment does not suffer by comparison with it.

There is an index, a list of localities, a guide map and a bibliography.

The reptilian fauna of the United States is roughly

comparable in size with that of China. Pope has, single-handed, done for China what has not yet been accomplished for the United States. Since our reptilian fauna is more similar to that of China than to that of any other Old World area, this book will be of great interest and usefulness to American students.

E. R. DUNN
HAVERFORD COLLEGE

SPECIAL ARTICLES

CAFFEIC ACID IN PRUNES AND ITS BEHAVIOR AS A LAXATIVE PRINCIPLE

IN studies on the laxative principle of prunes[1] it was observed that caffeic and chlorogenic acids caused an increase in tonus and amplitude of contraction of isolated rabbit jejunum or duodenum. This action was similar to that caused by various prune extracts.

In view of the forementioned results, an attempt was made to isolate chlorogenic and caffeic acids from dried Santa Clara prunes (Prune D'Agen) and determine their laxative actions. We were unable to obtain any indication of the presence of chlorogenic acid; however, caffeic acid crystals were obtained from the alkaline hydrolyzed water extract of prunes by the method of Plücker and Keilholz[2] and Freudenberg.[3] These crystals were definitely identified as caffeic acid by melting point, mixed melting point and elementary micro-analytical determinations. The latter gave C 56.75 per cent. and H 4.77 per cent. as compared with the theoretical values C 57.14 per cent. and H 4.76 per cent. Quantitative determinations indicate a concentration of about .03 per cent. caffeic acid in the whole dried prune. The variations in concentration of caffeic acid in prunes were not determined.

The source of caffeic acid in prunes is still uncertain. Since Kohman and Sanborn[4] reported the presence of quinic acid in prunes it was thought that the source might be chlorogenic acid, but, as already stated, this acid was not found to be present. Nierenstein[5] has suggested that these two acids are often combined in complex caffetannins.

Feeding tests with live rabbits, dogs and human subjects have failed to show any significant laxative effect, whereas in tests with isolated rabbit duodenum a slight change in tonus and amplitude was observed.

It is concluded that caffeic acid has been isolated from prunes and that it is not the substance responsible for the laxative action caused by the ingestion of prunes.

E. MRAK
J. FESSLER
C. SMITH
FRUIT PRODUCTS LABORATORY
UNIVERSITY OF CALIFORNIA

[1] G. A. Emerson, *Proc. Soc. Expt. Biol. and Med.*, 31: 278, 1933.

[2] W. Plücker and W. Keilholz, *Ztschr. f. Unters. der Lebensmittel*, Bd. 68, S. 97, 1934.

[3] K. Freudenberg, "Tannin Cellulose Lignin," Julius Springer, Berlin, 1933.

[4] E. F. Kohman and H. Sanborn, *Jour. Ind. Eng. Chem.*, 23: 126, 1931.

[5] M. Nierenstein, "The Natural Organic Tannins," J. and A. Churchill, Ltd., London, 1934.

THE EFFECT OF THE PERFORMANCE OF PHYSICAL WORK ON MIMOSA

IT is recognized that physical work or exercise within physiological limits makes the muscles of animals stronger and more difficult to fatigue. This investigation was begun to determine what effect, if any, the performance of physical work would have on the susceptibility of the plant, Mimosa, to fatigue, as well as on its capacity to perform work. For this purpose seven vigorous potted greenhouse plants of *Mimosa pudica* were used. The plants were approximately 30 cm high and had been grown from seeds sown 10 months earlier. Two leaves of approximately the same size of each plant were selected. One of these leaves was made to perform physical work, while the other, which served as a control, was not. It should be mentioned in this connection that the experiments were carried out in a greenhouse maintained at a temperature of approximately 26–27° C. and under natural conditions of day and night in January and February when the days were around 10 hours in length and the nights 14 hours.

The method of making the leaf perform physical work or so-called exercise was to attach weights to the leaf and then stimulate by dropping a cylindrical piece of wood 30 mms long and weighing 90 mgs through a glass tube 25 cm long and striking the junction of the four primary leaflets, as shown in Fig. 1. This stimulus caused the leaf to drop and when the leaf rose during the succeeding 15 minutes physical work was performed by raising the weight. Knowing the extent of rise of the leaf and the weight of the load lifted, the amount of work done could easily be calculated.

The experiments were performed in the following manner. At 9 A. M. a 115 mg weight was suspended at the junction of the four primary leaflets to one leaf of each of the seven plants to be worked or exercised, and these were then stimulated and caused to drop as described above and shown in Fig. 1. During the

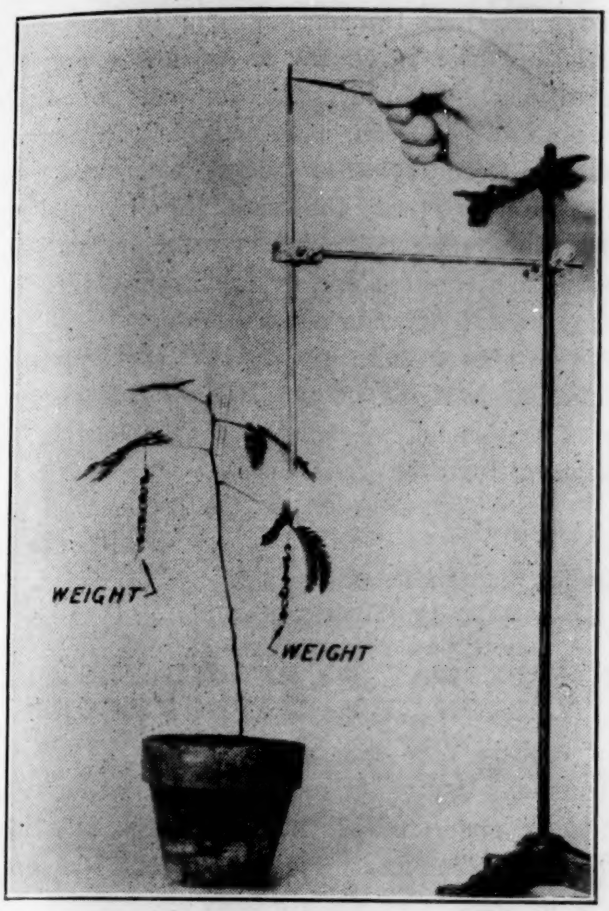

FIG. 1. Shows method of loading and stimulating Mimosa to make the plant perform physical work.

succeeding 15 or 20 minutes the leaves rose and in lifting the weights performed physical work. The weights were permitted to remain suspended to the leaves until the next morning at 9 A. M. when another 115 mg weight was added to each leaf and the same procedure of stimulating and working or exercising the leaves was repeated. This was continued for five days so that at the end of this period each leaf was carrying a 575 mg load, 115 mgs having been added each day for five days. The procedure was then reversed. One 115 mg weight was removed each day and the leaves were stimulated and made to perform physical work for five days while the load was being decreased.

In this manner, the leaves were made to perform physical work or take exercise for three 10-day periods, or 30 days. At the end of this time the following experiments were carried out to determine if the exercised leaves were able to perform more physical work and were less easily fatigued than the unexercised ones of the same plant. A 575 mg weight was suspended to each of the exercised as well as to the unexercised leaves of the same plant, as shown in Fig. 1, and each leaf was then stimulated and caused to drop. During the succeeding 60 minutes the leaves rose, lifted the weights and performed physical work, which was calculated and expressed in ergs. This was done by multiplying the load by lift by 980 to change to absolute units of work. At the end of the 60-minute period, the leaves were stimulated again and caused to drop, and the amount of work performed by raising the weights during the succeeding 60-minute period was also determined. It was found that the average amount of work performed by the exercised leaves was 2,874 ergs and that by the unexercised ones 2,029 ergs. By comparing these figures it will be seen that the exercised leaves performed 41 per cent. more work than the unexercised ones. It was also found that when the leaves were stimulated at several 60-minute intervals, as described above, the unexercised leaves fatigued more quickly than the exercised ones.

From the preceding experiments it may be concluded that the performance of physical work increases the capacity of the leaves of the plant, Mimosa, to do work and renders them more difficult to fatigue, an effect very similar to the action of physical work on the muscles of animals.

W. E. BURGE
G. C. WICKWIRE

UNIVERSITY OF ILLINOIS

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A NEW MICROCOLORIMETER

THIS instrument was devised primarily for bromsulphalein liver function tests in experiments in which but small quantities of blood were available. The apparatus consists of the following principal parts: telescope and prism of an ordinary colorimeter, microcells, microcell holder, round rotating carrier for standards, base and electric bulb, reflector and screen.

In the figure, the microcell holder is shown below the prism, in working position. The diagram of the holder represents the two separable parts, three microcell cups, the two vertical windows and the offset for accommodating the standard carrier. A standard microcell, *d,* and a microcell, *e,* holding the solution to be assayed, are shown mounted for observation in microcell cups. The cups, *f* and *g,* are each to be occupied by a microcell containing an appropriate blank which is used in order to provide the same media in both pathways of light. The vertical windows, including the portion of the window represented in the movable carrier for the standards, are slightly larger in cross-section than the corresponding cavities of the microcells. However, the central vertical axes of the cylindrical cells and windows are in perfect alignment.

Brass afforded a satisfactory material for the con-

struction of the standard carrier, the holder and the cells. The microcells were made with precision by drilling through the centers of the parallel surfaces on small identical brass disks. One of the parallel surfaces of the microcells was countersunk to hold the lower cover glass. By placing a cover glass over each parallel surface of the drilled disks, a microcell was provided with a fluid capacity of 0.06 cc. A cross-section of a microcell is indicated at *c*, in the diagram. A complete series of standards with any desired gradations may be distributed in the carrier. An automatic ball and spring stop, *h*, in the drawing, allows any standard to be stopped in the path of illumination.

The colored solutions and the blanks may, therefore, be interposed in the two light paths. The prism brings the light to a common axis. Looking into the telescope, the eye sees the divided field of the ordinary

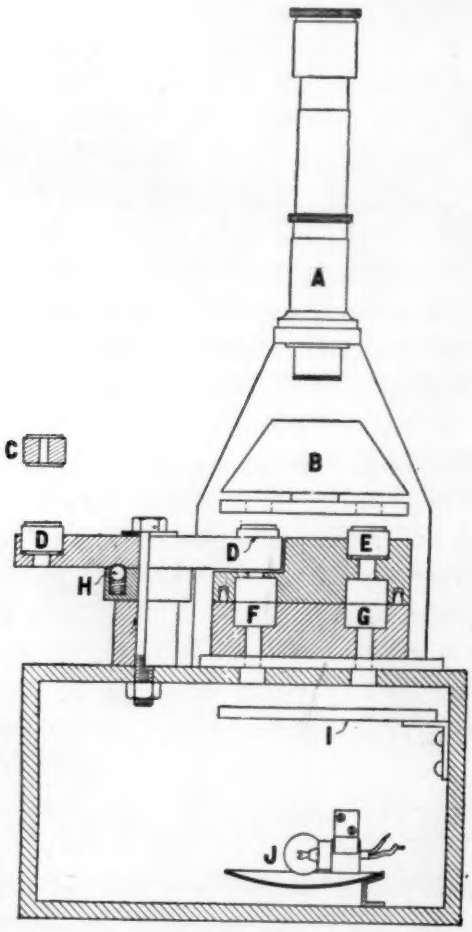

FIG. 1

colorimeter, and sharp color differentiation is possible. By moving the standard carrier, the value of the unknown solution may be approximated or matched with considerable accuracy.

Obviously, glass or bakelite cells, similarly constructed, may lend themselves to better adaptation for general colorimetric analysis than cells constructed from metal.

The arrangement of four cells in two combinations which allows the transmitted light to pass through parallel surfaces is, so far as we are aware, a new application in colorimetry. Simplicity of construction, ease of operation, wide possible application and reasonable accuracy when dealing with small quantities of solution justify the use of the new colorimeter. It is felt that the sacrifice of the usual vernier graduations is compensated for by the applicability to exceedingly small volumes of solutions.

The authors wish to give acknowledgment to J. S. Hipple, mechanician of the Medical School, University of Wisconsin, who designed and constructed the mechanical features of the instrument.

T. W. PRATT
A. L. TATUM

DEPARTMENT OF PHARMACOLOGY
UNIVERSITY OF WISCONSIN

AN EASY WAY TO REDUCE ELECTRIFICATION OF PARAFFIN RIBBONS[1]

IN cutting very thin sections with the microtome difficulty is often experienced with forces due to static electricity generated at the knife edge. Paraffin is such a poor conductor of electricity that the problem is one of leakage to the air from the general surface rather than of grounding. When the air is damp enough the leakage is rapid and no trouble results. For more than a year it has been the practice in this laboratory to produce "artificial weather" by boiling water in the room in which sectioning is being done. With sufficiently high humidity created in this manner, it is possible to cut ribbons as thin as 2 μ in any weather.

CHARLES WILSON
JOHN S. HOCKADAY

[1] From the laboratories of insect physiology and toxicology, Division of Entomology and Parasitology, University of California, Berkeley, California.

BOOKS RECEIVED

Reports of the First Scientific Expedition to Manchoukuo under the Leadership of Shigeyasu Tokunaga: NAKAI, TAKENOSHIN and others. *Contributio Ad Cognitionem Florae Manshuricae.* Section IV, Part II. Pp. 187. 19 plates. UENO, MASUZO, and others. *Crustacea of Jehol.* Section V, Part II, Division I. Pp. 52. Illustrated. DONO, TSURUMATSU. *On the Chemical Investigation of a Bronze Vessel Unearthed in the Vicinity of Pei-Piao in Chao-Yang Prefecture.* Section VI, Part I. Pp. 105. 29 plates. Faculty of Science and Engineering, Waseda University, Tokyo.

SIMMONS, JAMES S., Editor. *Laboratory Methods of the United States Army.* Fourth Edition. Pp. xix + 1091. 70 figures. Lea and Febiger. $6.50.

STONE, HANNAH and ABRAHAM STONE. *A Marriage Manual.* Pp. xi + 334. Illustrated. Simon and Schuster. $2.50.

Travaux de l'Association Internationale de Géodésie. Tome 11. Rapports Nationaux sur les Travaux Exécutes dans les Différents Pays. Établis a l'Occasion de la Cinquième Assemblée Générale. Union Géodésique et Géophysique Internationale, Paris.